

Cognition-guided **Surgery**



SFB/Transregio 125

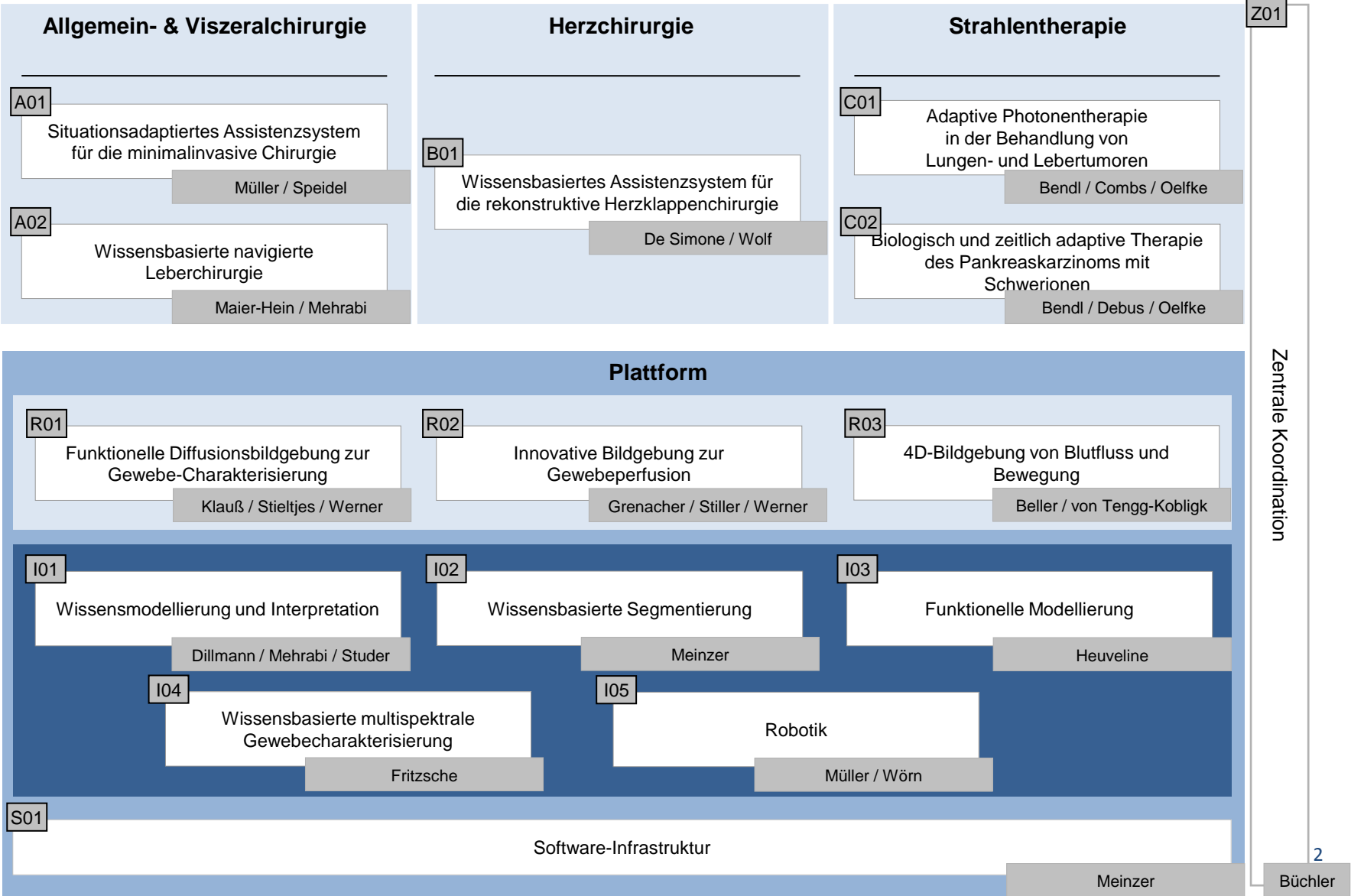
Challenges with Annotating Liver Patient Data

Benedikt Kämpgen, Andreas Adler, Patrick Philipp



Project Overview

SFB/Transregio 125





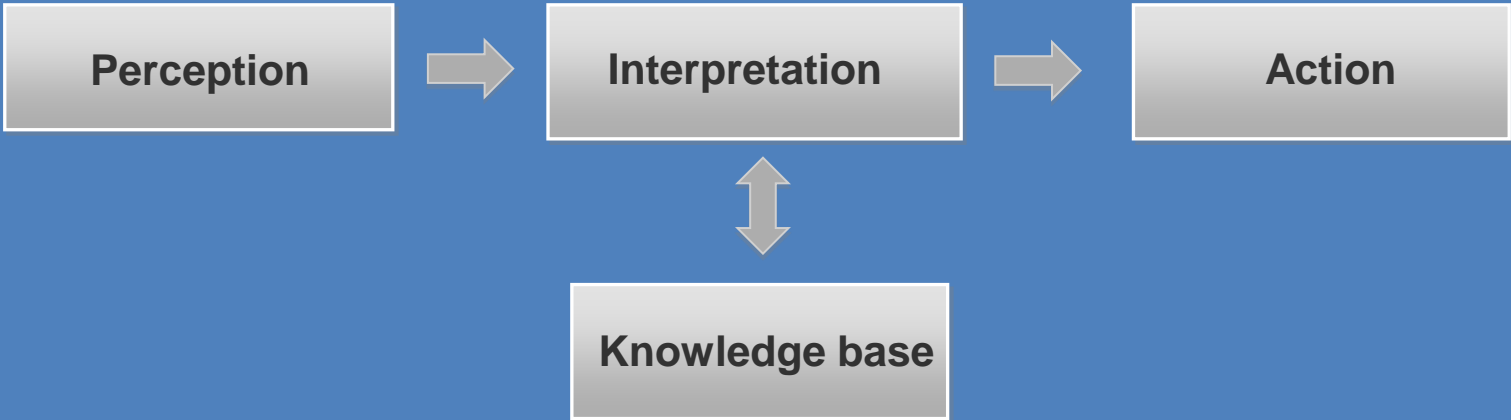
Surgical Use Cases

Assistance Systems



Recommending Liver Therapy

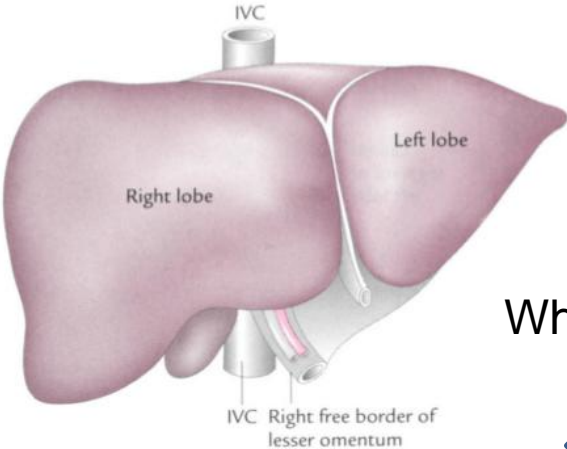
Cognitive Assistance System





Recommending Liver Therapy – Problem

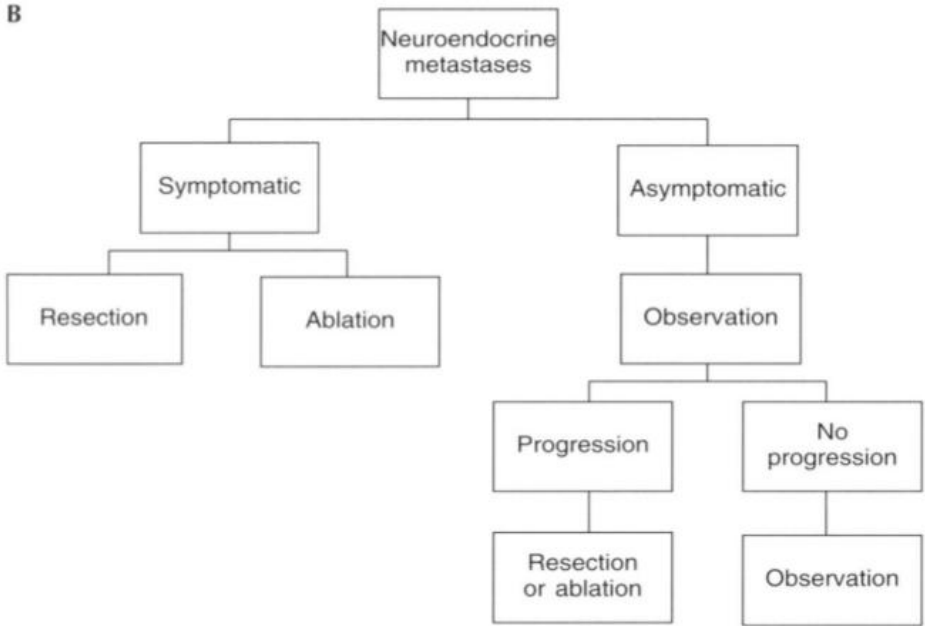
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What therapy?



Patient ID432

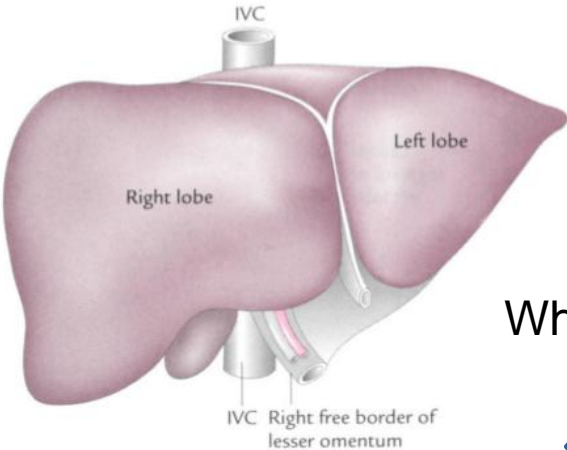


Study 654 Liver Guideline
Provided by A02 project



Recommending Liver Therapy – Problem

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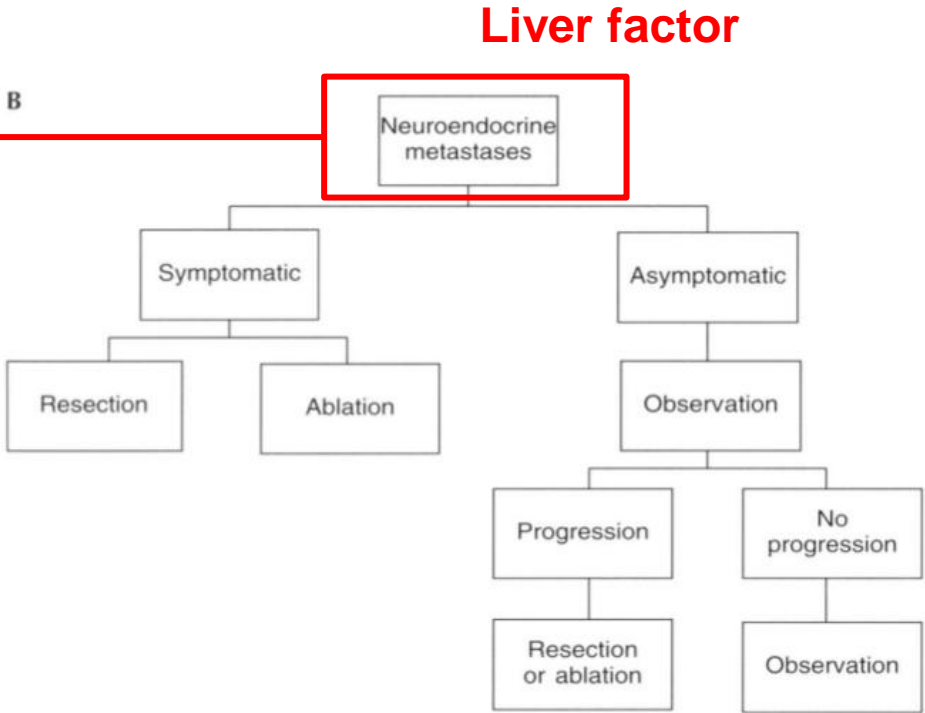


?

What therapy?



Patient ID432



Study 654 Liver Guideline
Provided by A02 project

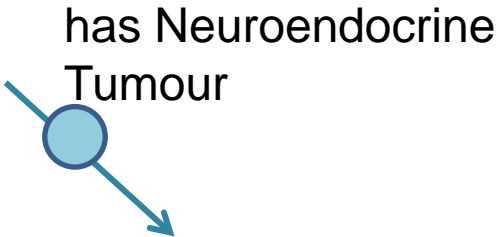


Recommending Liver Therapy – Problem (2)

SFB/Transregio 125

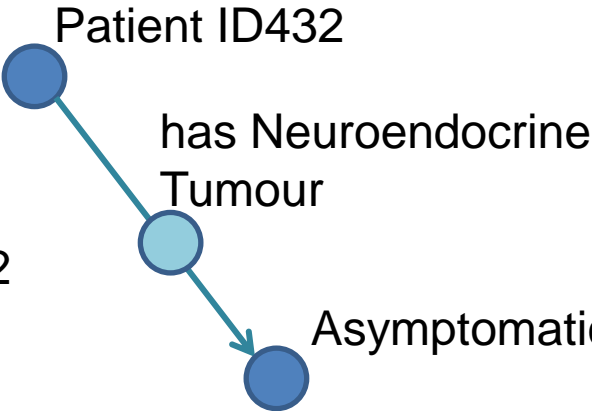
Describing liver factors

- Identifying relevant liver factors



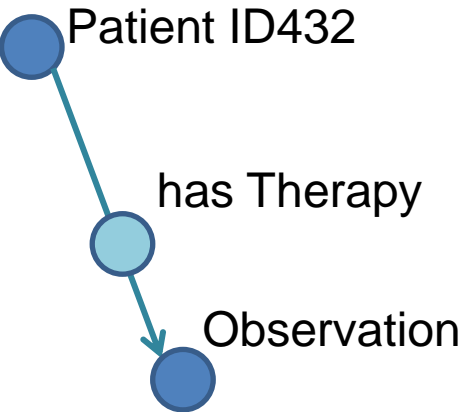
Annotating patients

- Fill out all relevant liver factors for patients



Evaluate guideline

- Derive new property for patient

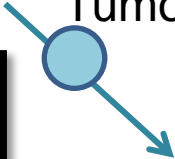




Recommending Liver Therapy – Problem (3)

SFB/Transregio 125

has Neuroendocrine
Tumour



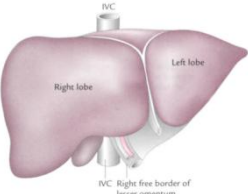
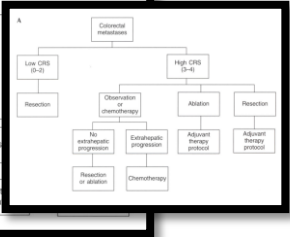
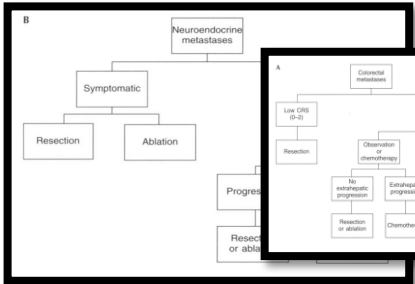
Pre-op 2	Demographic Data	Age (yr)	
		Gender	Male, Female, Intersex
		Race	Black , White , Yellow, Red, brown, AS
		Nationality	
		Weight (kg)	
		Height (m)	
		BMI	BMI = body weight (kg) / Height ² (m ²)
		Job	
		Diet Habit	Aflatoxins (rice, peanuts, corn,...)
		Habit	Smoke , Alcohol , Drug ...
		Patient Functional status	Independent , Partially dependent , Total

Liver factors

Therapy
guidelines



Patients





- **Security of patient data**
 - Only physicians in charge are allowed to see data set

- **Control of metadata and data**
 - Liver factors and patient data must not be changed by other projects

- **Ease of data input**
 - Forms but still flexible

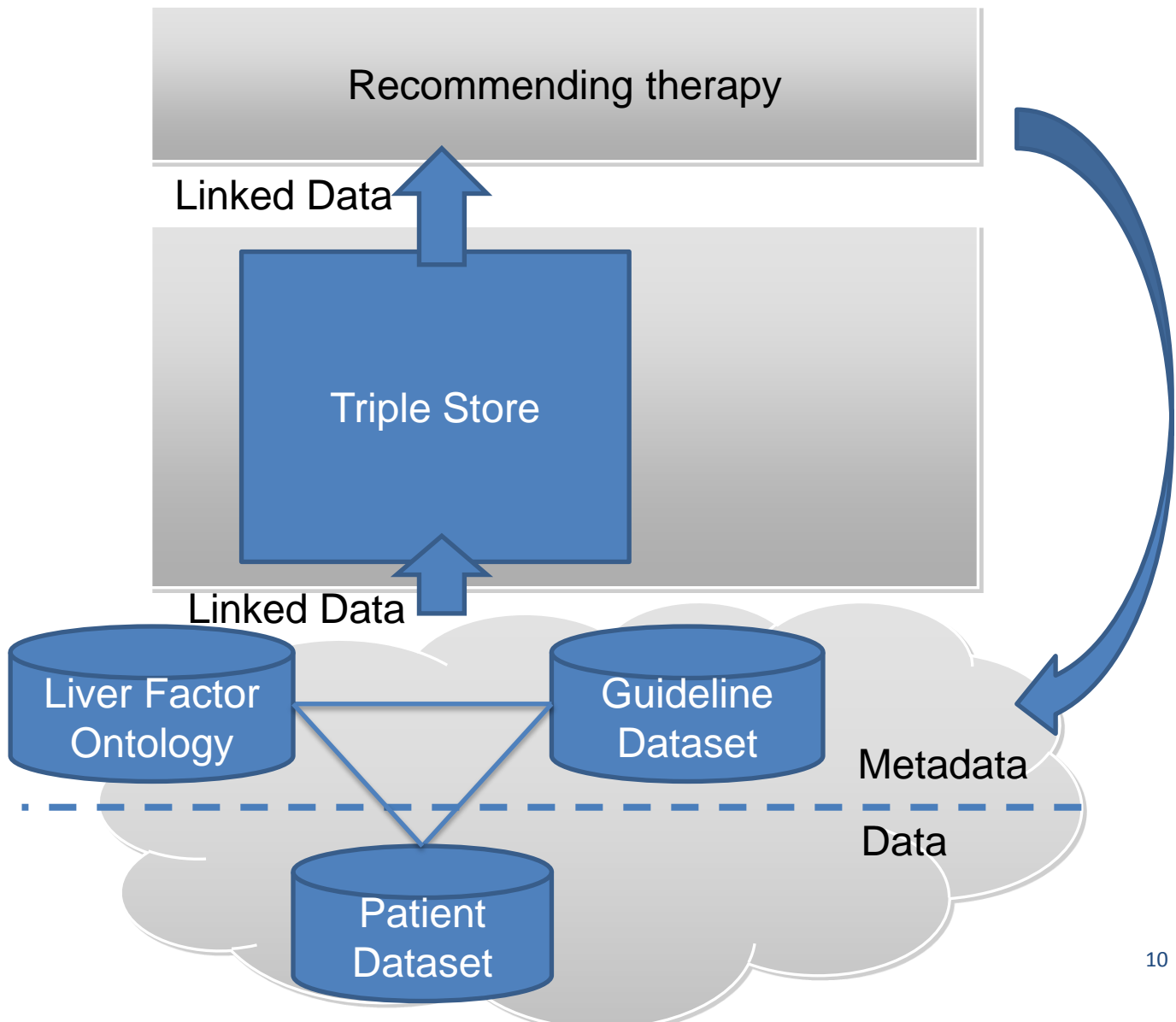


Recommending liver therapy – Solution

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Linked Data for

- Describing liver factors
- Annotating liver patients
- Describing guidelines



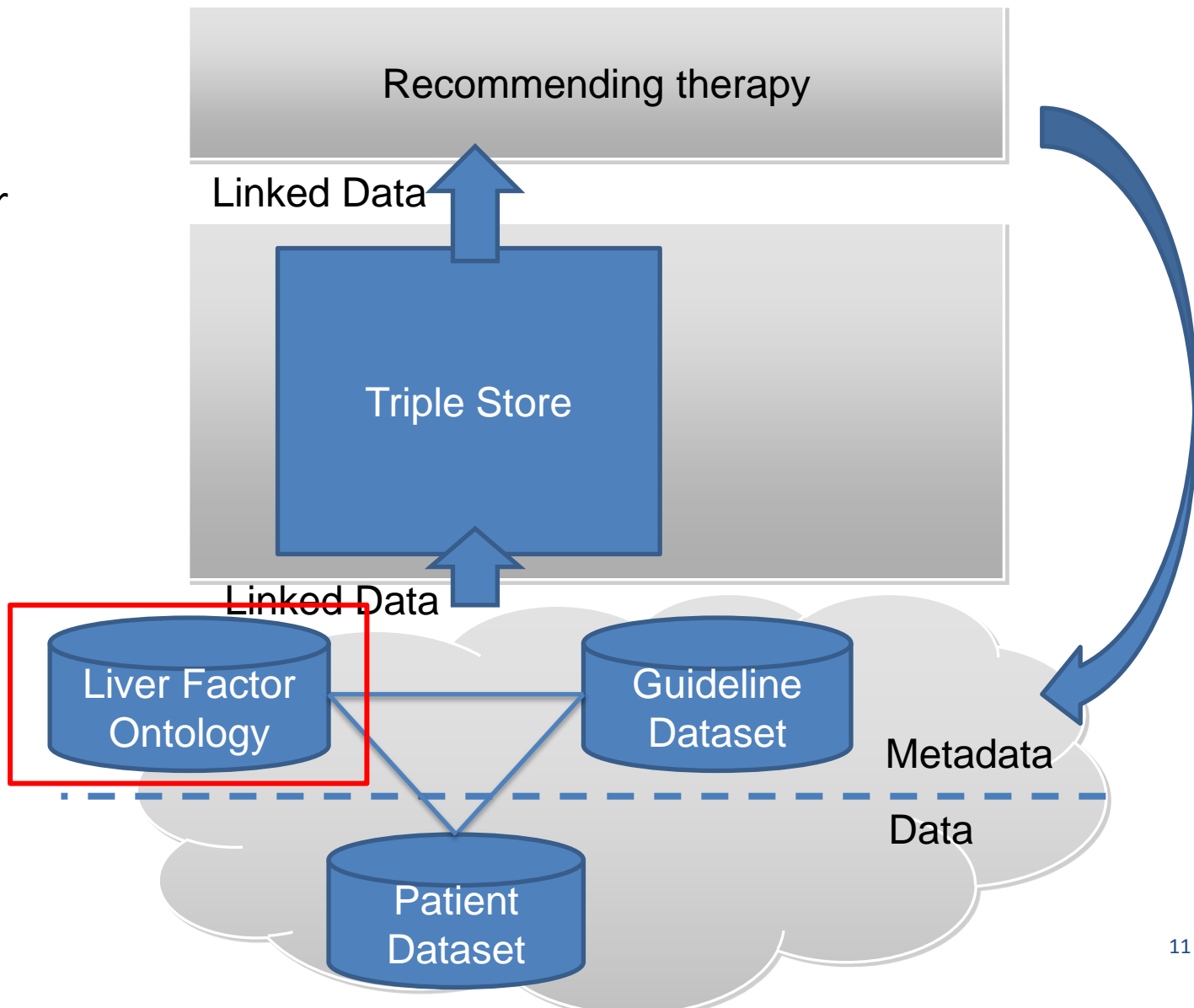


Recommending liver therapy – Solution

SFB/Transregio 125

Linked Data for

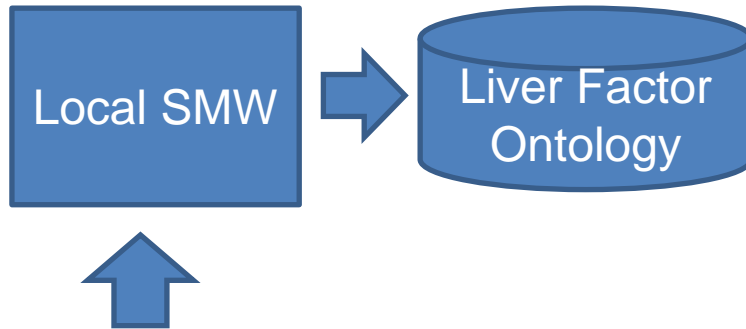
- Describing liver factors
- Annotating liver patients
- Describing guidelines





Describing liver factors

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	A	B	C	D	E
1			Fluid (Litre)	Ringer	
2				Nacl	
3				Glucose	
4				Others	
5			Koagulation Factors		
6			RBC		
7			FFP		
8			THK		
9			Hespan		
10			Plt (platelet)		
11			Alb		
12			Others		
13					

Problem

- Excel table
- > 500 liver factors
 - Preoperative, e.g., demographic data
 - Intraoperative, e.g., type of surgery
 - Postoperative, e.g., specific treatment

Solution

- Import of liver factors into SMW
- RDF export of liver factors as ontology



- **Ease of data input:** Excel table
- **Keep control over data:** Using local SMW



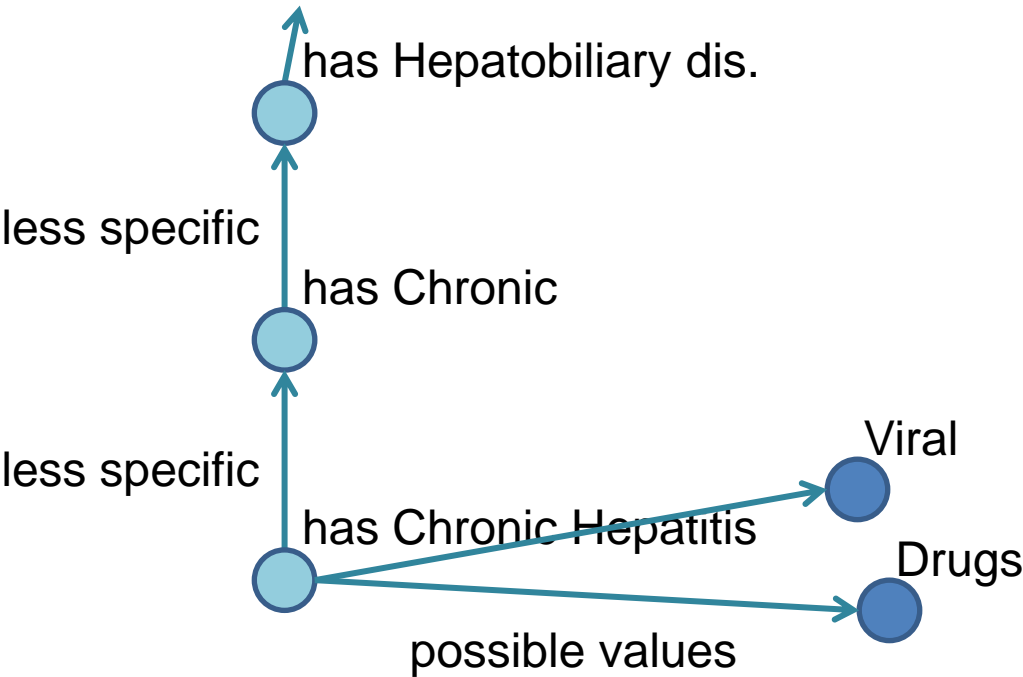
Describing liver factors – Modelling

SFB/Transregio 125

	Gastrointestinal	Hepatobiliary dis.	Chronic	Chronic Cirrhosis	
				Chronic Steatosis	
				Chronic Hepatitis	viral, bactrial, drugs, alcohol, autoimmune
				Chronic PSC	
				Chronic PBC	
				Chronic Budd chiari syn.	
				Chronic Other	
				Chronic Other	

Part of Excel Sheet

...

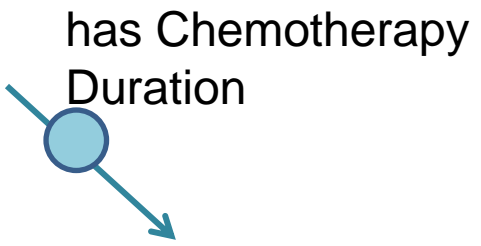
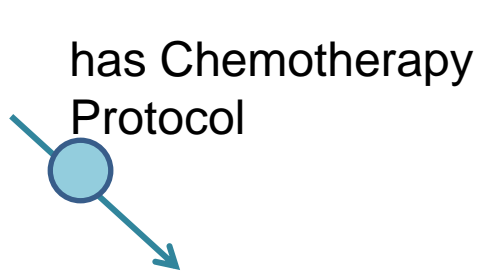




Describing liver factors – Complex Modelling

SFB/Transregio 125

9	Post-op	Oncological management		Protocol	Duration
10			Chemotherapy		
11			Radiotherapy		
12			RFA		
13			TACE		
14			Combination of them		
15		Re-operation	in hospital		
16					
17			After discharge		





Describing liver factors – Complex Modelling (2)

SFB/Transregio 125

			normal range	Unit	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9	Date 10
Electrolytes	Na		135-145	mmol/l										
	Mg		1.7-2.2	mg/dl										
	K		3.5-4.8	mmol/l										
	Ca		2.1-2.65	mmol/l										

Template:Laboratory Observation

This is the Laboratory Observation template. It should be called in the following format:

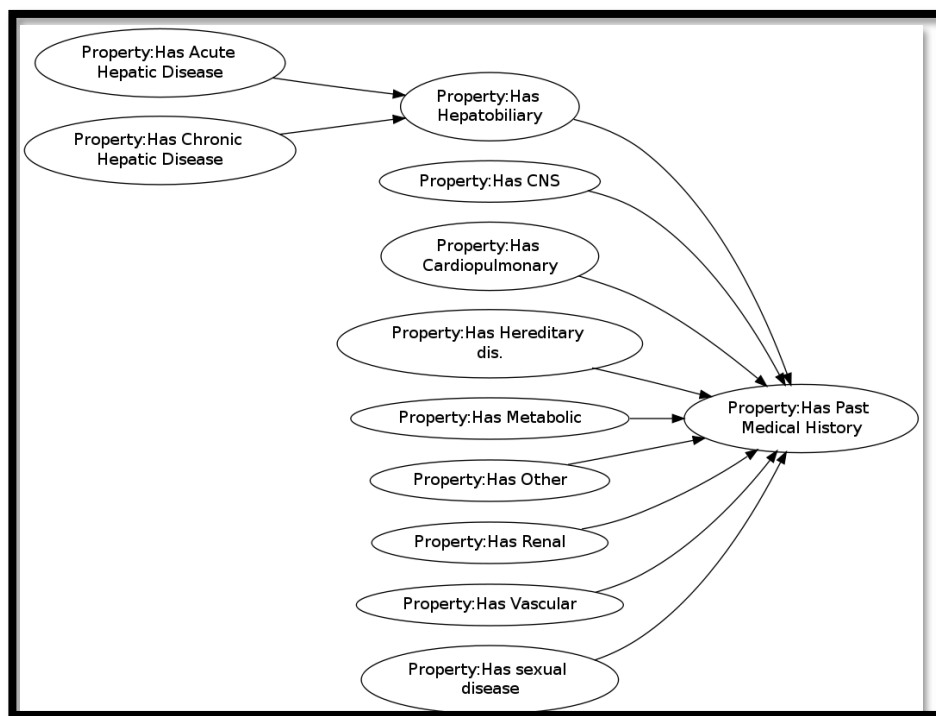
```
{{Laboratory
|has subject=
|has date=
|has numeric value=
|has unit=
|has description=
}}
```



Describing liver factors – Overviews

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- Overviews of liver factors: tree, graph



Property Tree Visualisation

Contents [\[hide\]](#)

- 1 Pre-Op
- 2 Intra-Op
- 3 Post-Op

Notes: Tree of properties is grouped by Pre-Op, Intra-Op, Post-Op. You can change the data in the database.

Pre-Op

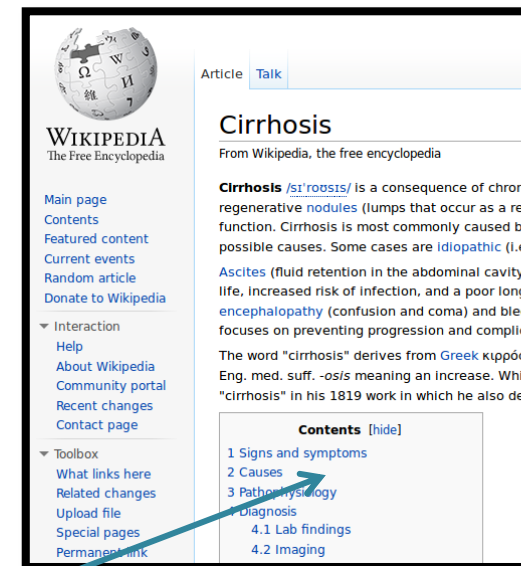
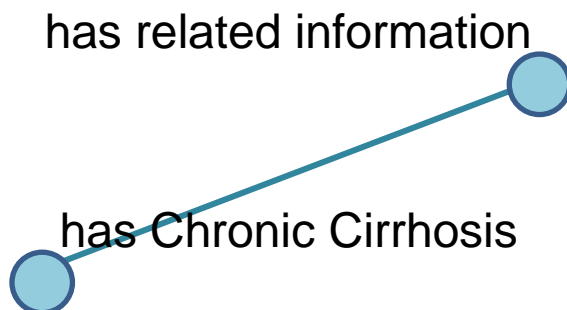
- **Has Demographic Data**
 - Has Age
 - Has Age (yr)
 - Has BMI
 - Has Diat
 - Has Gender
 - Has Habit
 - Has Height
 - Has Job
 - Has Patient Functional status
 - Has Race
 - Has Weight
- **Has Endoscopic Evaluation**
 - Has Colonoscopy
 - Has ERCP



Describing liver factors – Background info

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- Physicians would not add background information
- Meaning of liver factors or possible values sometimes not clear
- linking to external data sources, e.g., Wikipedia





- Type of properties have to be guessed or “page” by default
- Liver factor refinement process
 - Teach physicians to further describe liver factors using SMW, e.g., data types of properties
 - New versions of Excel sheet -> no round-tripping
 - Exceptions are the rule (Excel)
- Without data, difficult to validate modelling

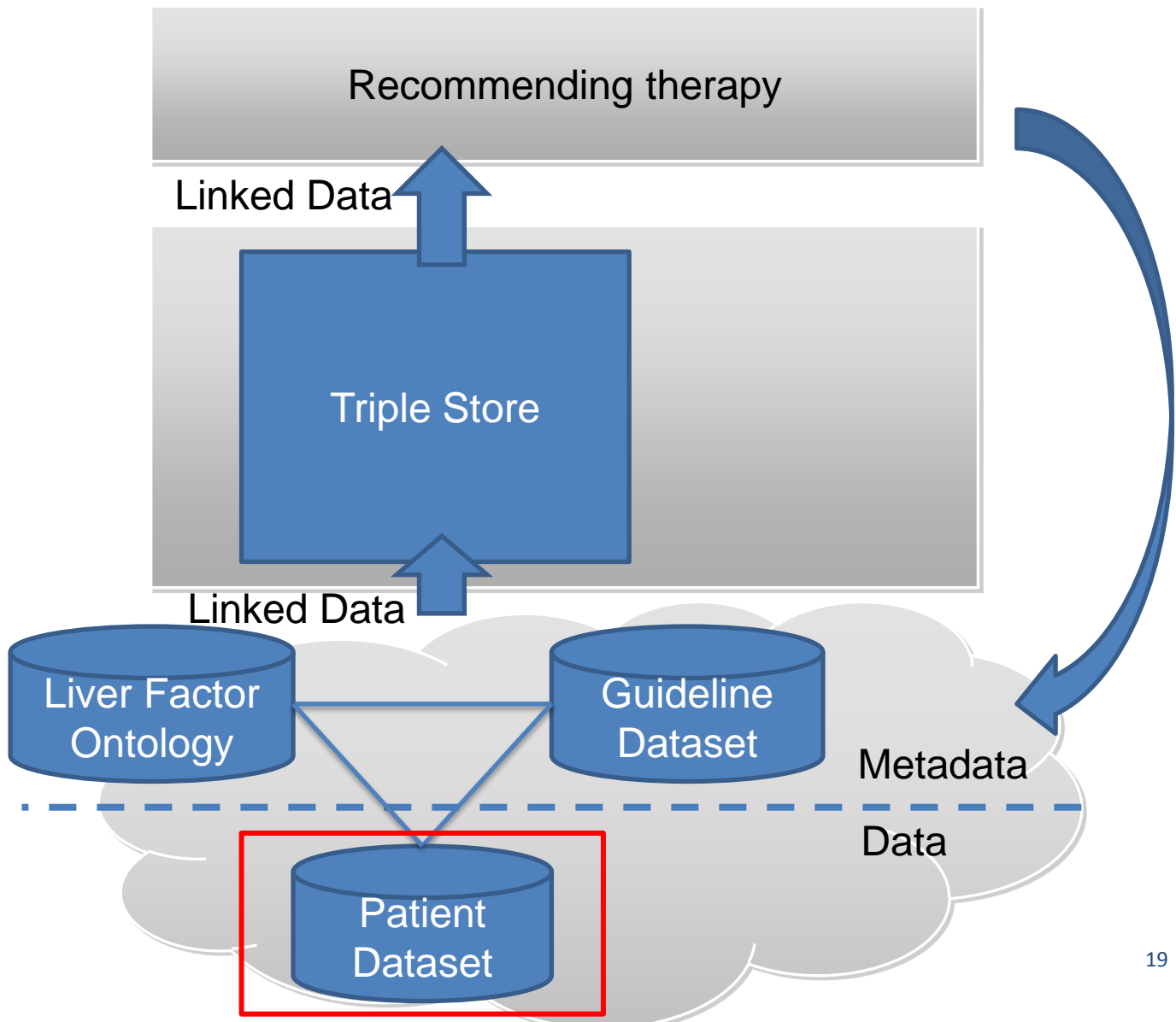


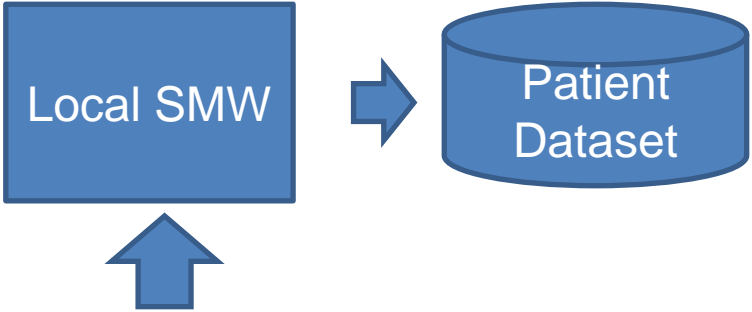
Recommending liver therapy – Solution

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Linked Data for

- Describing liver factors
- Annotating liver patients
- Describing guidelines





Intra-OP- 5	IV Substitution	Fluid (Litre)	Ringer	
			Nacl	
			Glucose	
			Fluid (Litre)	
			Others	
		Koagulation Factors		
		RBC		
		FFP		
		THK		
		Hespan		
		Plt (platelet)		
		Alb		
		IV Substitution Others		

Problem

- Paper-based patient folders
- > 50 patients á several dozens of pages
- Excel-like data input (ordering...)

Solution

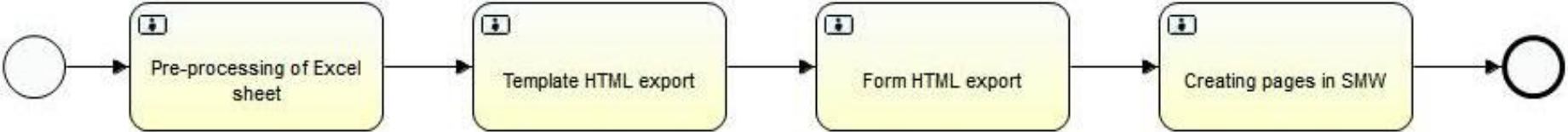
- Semantic Forms
- Annotations reusing liver factor ontology
- RDF export and secure storage of patient data
- **Ease of data input:** Forms
- **Security of patient data:** Created using local SMW, stored on secure file server





Annotating liver patients - Basic idea

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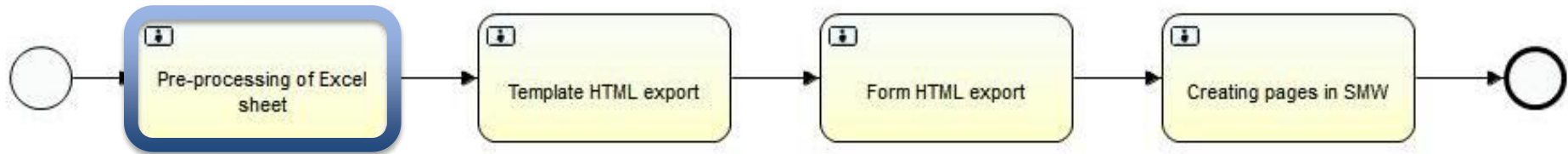
Leberfaktorentabelle originally 14.09.2013 co

Datei Start Einfügen Seitenlayout Formeln Daten Überprüfen Ansicht Entwicklertools				
Einfügen				
Zwischenablage				
Schriftart				
Ausrichtung				
Leberfaktorentabelle originally 14.09.2013 co				
114 fx				
	A	B	C	D
1	<u>Intra-OP- 5</u>	IV Substitution	Fluid (Litre)	Ringer
2				Nacl
3				Glucose
4				Others
5			Koagulation Factors	
6			RBC	
7			FFP	
8			THK	
9			Hespan	
10			Plt (platelet)	
11			Alb	
12			Others	
13				



Pre-processing of Excel sheet

SFB/Transregio 125



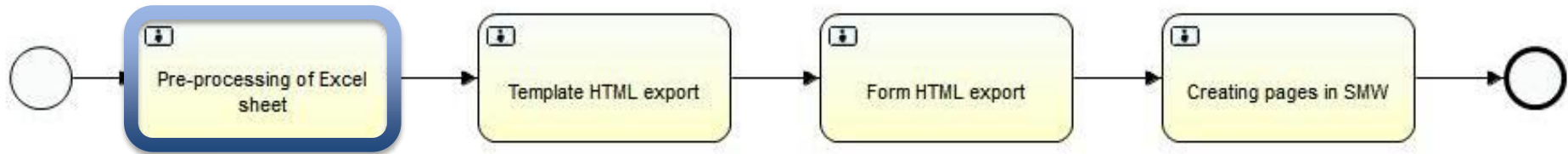
- The last (most specific) column is used for the property name

	A	B	C	D
1	<u>Intra-OP- 5</u>	IV Substitution	Fluid (Litre)	Ringer
2				Nacl
3				Glucose
4				Fluid (Litre) Others
5			Koagulation Factors	
6			RBC	
7			FFP	
8			THK	
9			Hespan	
10			Plt (platelet)	
11			Alb	
12			IV Substitution Others	



Pre-processing of Excel sheet

SFB/Transregio 125



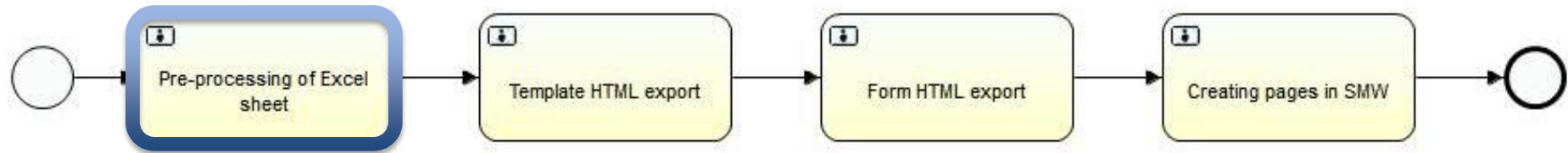
- The last (most specific) column is used for the property name

	A	B	C	D
1	<u>Intra-OP- 5</u>	IV Substitution	Fluid (Litre)	Ringer
2				Nacl
3				Glucose
4				Fluid (Litre) Others
5			Koagulation Factors	
6			RBC	
7			FFP	
8			THK	
9			Hespan	
10			Plt (platelet)	
11			Alb	
12			IV Substitution Others	



Pre-processing of Excel sheet

SFB/Transregio 125



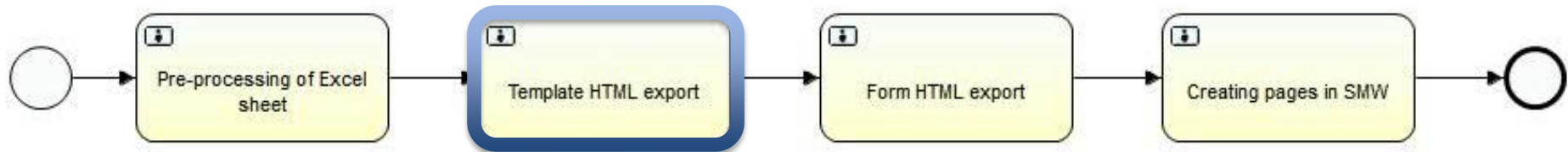
- The last (most specific) column is used for the property name

	A	B	C	D	G
1	<u>Intra-OP- 5</u>	IV Substitution	Fluid (Litre)	Ringer	Ringer
2				Nacl	Nacl
3				Glucose	Glucose
4				Fluid (Litre) Others	Fluid (Litre) Others
5			Koagulation Factors		Koagulation Factors
6			RBC		RBC
7			FFP		FFP
8			THK		THK
9			Hespan		Hespan
10			Plt (platelet)		Plt (platelet)
11			Alb		Alb
12			IV Substitution Others		IV Substitution Others



Template HTML export

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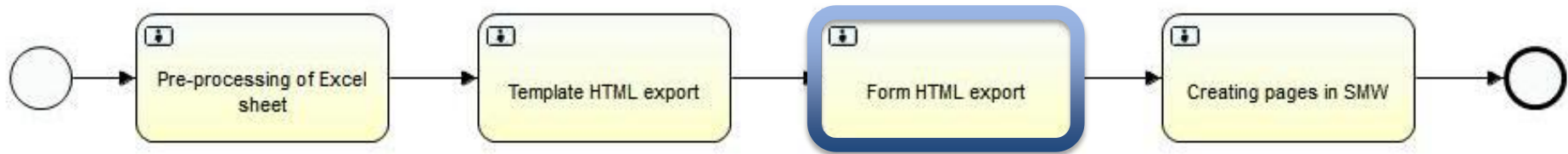
- The last (most specific) column is used for the property name
- We insert template fields for each property in Excel sheet

	A	B	C	D	F
1	<u>Intra-OP- 5</u>	IV Substitution	Fluid (Litre)	Ringer	[[Has Ringer::{{{has Ringer}}}}]]
2				Nacl	[[Has Nacl::{{{has Nacl}}}}]]
3				Glucose	[[Has Glucose ::{{{has Glucose }}}}]]
4				Fluid (Litre) Others	[[Has Fluid (Litre) Others::{{{has Fluid (Litre) Others}}}}]]
5			Koagulation Factors		[[Has Koagulation Factors::{{{has Koagulation Factors}}}}]]
6			RBC		[[Has RBC::{{{has RBC}}}}]]
7			FFP		[[Has FFP::{{{has FFP}}}}]]
8			THK		[[Has THK::{{{has THK}}}}]]
9			Hespan		[[Has Hespan ::{{{has Hespan }}}}]]
10			Plt (platelet)		[[Has Plt (platelet)::{{{has Plt (platelet)}}}}]]
11			Alb		[[Has Alb::{{{has Alb}}}}]]
12			IV Substitution Others		[[Has IV Substitution Others::{{{has IV Substitution Others}}}}]]



Form HTML export

SFB/Transregio 125



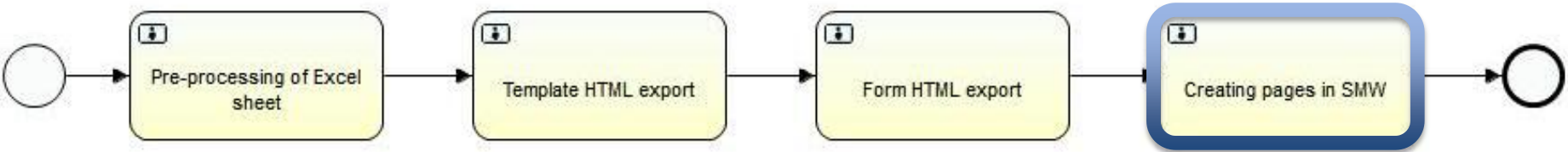
- The last (most specific) column is used for the property name
- We insert template fields for each property in Excel sheet
- We insert form fields for each property in Excel sheet

	A	B	C	D	F
1	<u>Intra-OP- 5</u>	IV Substitution	Fluid (Litre)	Ringer	{{{field has Ringer}}}
2				Nacl	{{{field has Nacl}}}
3				Glucose	{{{field has Glucose}}}
4				Fluid (Litre) Others	{{{field has Fluid (Litre) Others}}}
5			Koagulation Factors		{{{field has Koagulation Factors}}}
6			RBC		{{{field has RBC}}}
7			FFP		{{{field has FFP}}}
8			THK		{{{field has THK}}}
9			Hespan		{{{field has Hespan}}}
10			Plt (platelet)		{{{field has Plt (platelet)}}}
11			Alb		{{{field has Alb}}}
12			IV Substitution Others		{{{field has IV Substitution Others}}}



Creating pages in SMW – Template

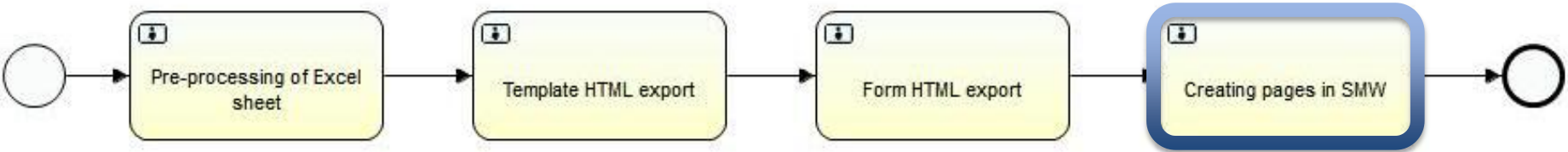
SFB/Transregio 125



IV Substitution				
Edit IV Substitution				
<u>Intra-OP-5</u>	IV Substitution	Fluid (Litre)	Ringer	Unknown ⚠
			Nacl	Unknown ⚠
			Glucose	Unknown
			Fluid (Litre) Others	Unknown
		Koagulation Factors		No
		RBC		Yes
		FFP		Yes
		THK		No
		Hespan		No
		Plt (platelet)		No
		Alb		No
		IV Substitution Others		No



Creating pages in SMW – Form



<u>Intra-OP-5</u>	IV Substitution	Fluid (Litre)	Ringer	
			Nacl	
			Glucose	
			Fluid (Litre)	
			Others	
		Koagulation Factors		
		RBC		
		FFP		
		THK		
		Hespan		
		Plt (platelet)		
		Alb		
		IV Substitution		



Annotating liver patients – Complex modelling

Post-op 1

Edit Post-op 1

Post-op 1	Specific treatment	Vit K	No	
		FFP	No	
		EK (Erythrozytenkonzentrat)	No	
		THK (Thrombozytenkonzentrat)	No	
		Antibiotic	yes	
		Magnesium	No	
		Potassium	no	
		Specific treatment Others	No	
	Oncological management		Protocol	Duration
		Chemotherapy	No	
Radiotherapy		No		
RFA		No		
TACE		No		
Combination of them		No		
Re-operation	in hospital	no		
	After discharge	no		

1	Oncological management	Chemotherapy		
Radiotherapy				
RFA				
TACE				
Combination of them				
Re-operation		in hospital		
	After discharge			



Annotating liver patients – Complex modelling (2)

					normal range	Unit	2013-01-22	2013-01-24	2013-01-26	2013-01-28	2013-02-12
		Electrolytes	Na		135-145	mmol/l	142	143	148	150	137
			Mg		1.7-2.2	mg/dl					
			K		3.5-4.8	mmol/l	4.6	3.75	4.14	4.10	5.86
			Ca		2.1-2.65	mmol/l	2.01	1.97	2.16	2.36	2.11
		Renal & urine	Urin Bilirubin		0						
			Renal & urine Urea	(Urea)	to 45	mg/dl					
			Renal & urine Creatinin	(Creatinin)	0.1-1.3	mg/dl					
		ABG (Arterial Blood Gas)	PH		7.35-7.45		7.32	7.39	7.43	7.48	7.49

					normal range	Unit		
		Electrolytes	Na		135-145	mmol/l		
			Mg		1.7-2.2	mg/dl		
			K		3.5-4.8	mmol/l		
			Ca		2.1-2.65	mmol/l		
		Renal & urine	Urin Bilirubin		0			
			Renal & urine Urea	(Urea)	to 45	mg/dl		
			Renal & urine Creatinin	(Creatinin)	0.1-1.3	mg/dl		
		ABG	PH		7.35-7.45			



- 5 student physicians inserting data
- 20 patients annotated
- Overviews created

Page

Discussion

Read

View source

View history

Patient Table

Patients

To add new patients to this table, see [Create new patient](#).

	Has form status	Has Name	Has Age (yr)	Has Gender	Has Race	Has Height	Has Weight	Has BMI	Has Job	Has Habit
--	-----------------	----------	--------------	------------	----------	------------	------------	---------	---------	-----------

- Helps with understanding „structured data“



- Liver Factor Update Process: Decrease manual effort of technicians
 - Changing user interface -> annoying, but well...
 - Changing liver factors -> what happens to earlier annotated patients?
- Increase quality but stay flexible, e.g.,
 - "60 minuts"
 - "Unknown"/"unknown"/"not known"
 - German Dates 1.2.2013
- Improve user experience for physicians

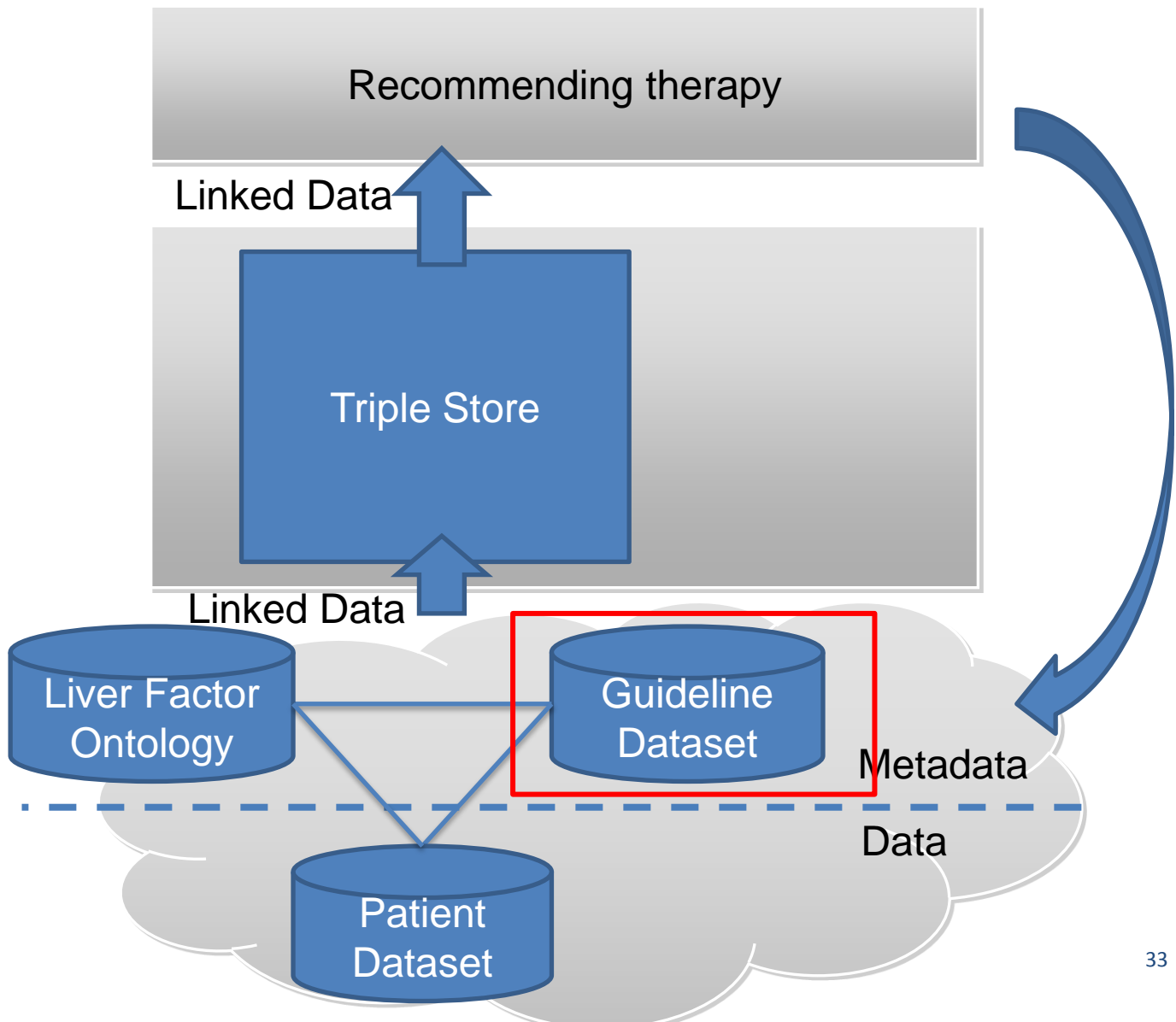


Recommending liver therapy – Solution

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Linked Data for

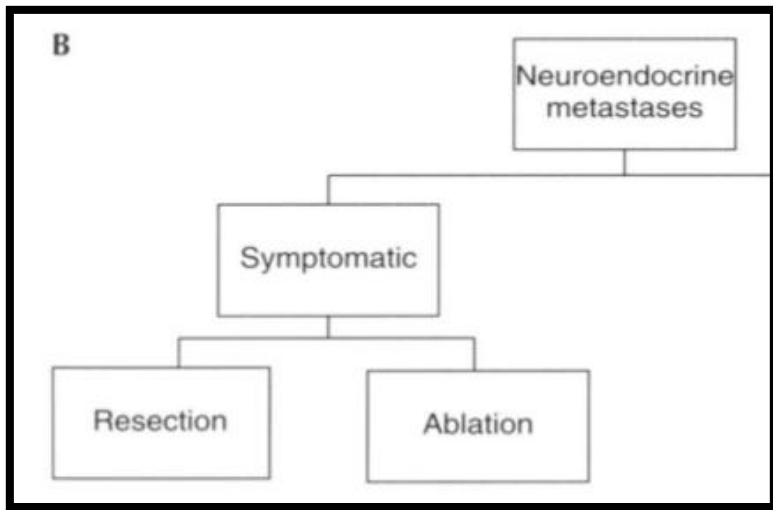
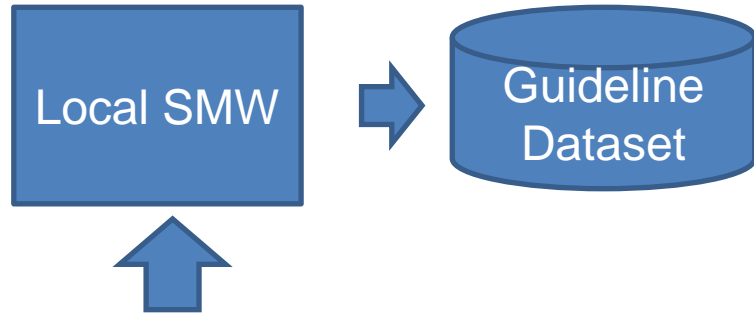
- Describing liver factors
- Annotating liver patients
- Describing guidelines



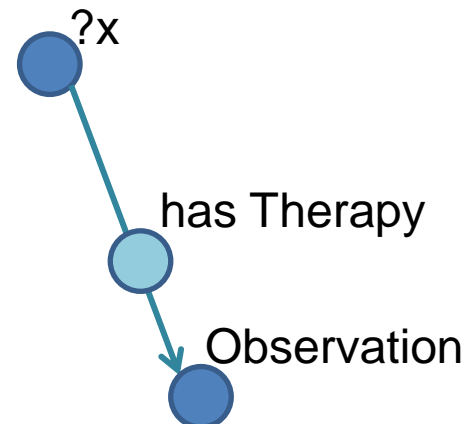
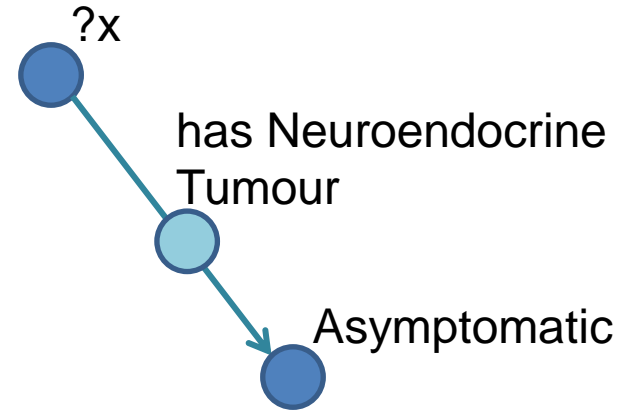


Describing guidelines

SFB/Transregio 125



Study 654 Liver Guideline





- Modelling guidelines in SMW, e.g., easy to use rule editor
- Execution of guidelines (e.g., rules using SPARQL Update)
- Dealing with conflicting guidelines



- Special requirements of medical domain
 - Sensitive patient data
 - Control over data
 - Difficult for physicians to get head around „structured data“

- SMW great for working towards a common vocabulary for mapping between liver factors as described
 - in scientific literature
 - in clinical guidelines
 - in actual patients



Thanks

SFB/Transregio 125

Linked Data for

- Describing liver factors
- Annotating liver patients
- Describing guidelines

